

REMARKS

The Office Action of July 28, 2004 has been reviewed and the Examiner's comments carefully considered. Claims 1-9 are currently pending in this application. Claims 2, 3, 5, 7 and 9 have been canceled. Claim 10 has been added. No new subject matter has been added by this amendment. In view of the amendments and the following explanation, Applicants believe that all the rejections should be withdrawn and all the claims are in condition for allowance.

Claims 1-9 stand rejected under 35 U.S.C. 103(a) for purported obviousness over U.S. Patent No. 4,754,039 to Michalowicz et al. The Examiner asserts that Michalowicz et al. teach the instant process, but that Michalowicz et al. teach the production of a generic compound versus a disclosed species, thus it would be obvious to select various known radicals within a genus to prepare structurally similar compounds in the absence of showing unexpected results for the claimed process over those of the generic prior art process. Additionally, the Examiner cites U.S. Patent No. 4,537,971 to Rebhahn et al. as teaching the production of pyridine, 2,3-dicarboxylic acid and makes the same assertion that it would be obvious to select various known radicals within a genus to prepare structurally similar compounds. Applicants note that the Examiner has not stated a rejection based on Rebhahn et al., but patentability thereover is discussed anyhow.

The claimed invention inheres in a process for producing 2,3-pyridinedicarboxylic acid, wherein the critical feature of the invention is that part or all of the solution, i.e., filtrate or mother liquor, obtained after the filtration of the precipitated 2,3-pyridinedicarboxylic acid in step (c) is essentially free of organic impurities, and is thus recycled to the oxidation step (a) or (b). Moreover, the filtrate also contains a substantial amount of the remaining 2,3-pyridinedicarboxylic acid product, which is very pure due to the lack of organic impurities in the filtrate. Thus, recycling of the filtrate obtained in step (c) after filtration of the 2,3-pyridinedicarboxylic acid thereof, without the need for a purification step, results in a significant increase of product yield with no decrease in the purity of the product. Therefore, the unexpected and significant advantages of the claimed invention are the ability to recycle

essentially pure filtrate which contains the 2,3-pyridinedicarboxylic acid product, in order to produce a surprisingly high, pure yield of product.

The unexpected and significant advantages of the claimed invention are due to the fact that, although the oxidation reaction of quinoline in step (a) results in the formation of a considerable amount of organic by-products, the copper salt of 2,3-pyridinedicarboxylic acid precipitated in step (a) is of high purity because of its extremely low solubility. In contrast, organic impurities are highly soluble. Thus, the process of the claimed invention results in obtaining the copper salt in a pure form which does not contain any appreciable organic impurities after the highly soluble organic impurities have been removed by washing. In step (b), the pure copper salt of 2,3-pyridinedicarboxylic acid is reacted with an alkali to dissolve the salt, and the resulting solution is reacted with an acid in step (c) in order to precipitate the 2,3-pyridinedicarboxylic acid, which is then separated from the solution by filtration. The filtrate (or mother liquor) obtained by filtration of the precipitated acid in step (c) therefore is very clean and contains essentially no organic impurities. Additionally, the solubility of 2,3-pyridinedicarboxylic acid separated in step (c) is much higher than its copper salt which is separated in step (a). Therefore, the filtrate obtained upon filtration of the precipitated acid product in step (c) contains an appreciable amount of 2,3-pyridinedicarboxylic acid, which is recycled to step (a) or (b) as per claim 1 or recycled to step (a) as per new claim 10, without the need to purify the filtrate because of the lack of organic impurities, resulting in a significant increase of product yield with no decrease in the purity of the product.

In contrast to the above, Michalowicz et al. do not teach or suggest recycling any solution obtained in their process. This is not surprising because recycling of a filtrate containing 2,3-pyridinedicarboxylic acid to a preceding step of the production process typically causes a substantial amount of organic impurities in the filtrate, which results in significant contamination of the reaction system. Hence, any recycling of the filtrate containing 2,3-pyridinedicarboxylic acid product would necessitate purification of the filtrate before recycling, adding greatly to the cost of manufacture. Additionally, there is typically a low content of 2,3-pyridinedicarboxylic acid product in the filtrate, so that recycling of the filtrate would not result in a significant increase in product yield.

Because recycling is essential to achieve the significant and surprising advantages of the claimed invention, as discussed above, Applicants submit that it would not be obvious to one skilled in the art to recycle the filtrate resulting from step (c) from the teachings of Michalowicz et al.

Rebhahn et al. disclose a process for producing quinolinic acid, i.e., 2,3-pyridinedicarboxylic acid, comprising oxidizing quinoline with hydrogen peroxide in an aqueous sulfuric acid solution in the presence of copper sulfate in order to precipitate copper quinolate and then converting the collected copper quinolate to quinolinic acid by reaction with an alkali to form a water soluble alkali salt, followed by reacting the resulting solution with an acid to precipitate quinolinic acid, which is then collected by filtration. The purity of the quinolinic acid produced therefrom is very low. More importantly, Rebhahn et al. do not teach or suggest the critical feature of the claimed invention, which is the recycling of the filtrate obtained by filtration of the quinolinic acid in the final step to be used as a solvent in the first oxidizing step without requiring additional steps before such recycling. Instead, Rebhahn et al. disclose treating the filtrate with solid copper sulfate to cause the quinolinic acid present in the filtrate to precipitate as a copper salt, collecting the copper salt, and recycling the copper salt to quinolinic acid in future conversions (column 7, lines 35-45). Although the Rebhahn et al. process results in an increased yield of the quinolinic acid product, the Rebhahn et al. process requires the additional steps of reacting the filtrate with copper sulfate or another copper compound and subsequently collecting the precipitate by filtration. More importantly, the recycling method disclosed in Rebhahn et al. does not achieve the significant reduction in the oxidation reaction in step (a), which is another unexpected result achieved by the claimed invention.

The unexpected and significant advantages of the claimed invention are demonstrated from the comparison between comparative Example 1 and working Example 1 contained in the specification. In comparative Example 1, where no recycling of the filtrate is performed, the purity of the product was 99.8% and the yield was 50.9%. In contrast, in working Example 1, where only 270 grams of the 350 grams of the filtrate obtained in step (c) was recycled to step (a) as a solvent, the resulting purity of the product was 99.9% and the yield was 58.2%. Thus, if all of the filtrate was recycled the yield would be increased further. Working

Example 1 demonstrates that the process of the claimed invention results in a significant increase in yield with no decrease in the purity of the product, which is a significant advantage for the commercial production of the product.

Furthermore, another notable advantage of the claimed invention is that the reaction time which is required to complete the oxidation reaction in step (a) is significantly reduced by recycling the filtrate in step (c) to step (a), i.e., using the filtrate as a solvent in step (a). This is demonstrated as well from the comparison provided in comparative Example 1 and working Example 1. In comparative Example 1, the time required to complete the oxidation reaction was 17 hours. In contrast, in working Example 1, it took only 10 hours to complete the same oxidation reaction under the same conditions. Such a large reduction in reaction time by recycling the filtrate is surprising and would not be expected by those skilled in the art.

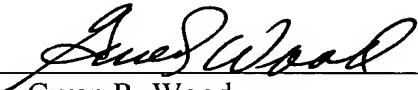
In conclusion, Applicants submit that the new and unexpected results of the claimed invention are neither taught nor suggested by Michalowicz et al. or Rebhahn et al., either alone or in combination. Indeed, Rebhahn et al. teaches away from the novel process of the claimed invention by requiring additional steps prior to filtrate recycling. Thus, it would not be obvious to one skilled in the art to directly recycle the filtrate produced from step (c) to use it as a solvent in step (a) or step (b) without additional steps of extensive purification of the filtrate.

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For all the foregoing reasons, claims 1, 4, 6, 8 and 10 are patentable over the cited prior art and in condition for allowance. Withdrawal of the asserted rejections and allowance of all pending claims 1, 4, 6, 8 and 10 are respectfully requested.

Respectfully submitted,

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